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Graphene oxide-based hydrogels to make metal nanoparticle-containing reduced graphene oxide-based functional hybrid hydrogels

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Abstract

In this study, stable supramolecular hydrogels have been obtained from the assembly of graphene oxide (GO) in presence of polyamines including tris(aminoethyl)amine, spermine, and spermidine [biologically active molecule]. One of these hydrogels has been well characterized by various techniques including field-emission scanning electron microscopy (FE-SEM), transmission electron microscopy (TEM), atomic force microscopy (AFM), X-ray diffraction (XRD) study, and Raman spectroscopy. TEM and AFM studies of one of these hydrogels have revealed the presence of a network structure of cross-linked nanosheets. This suggests the supramolecular assembly of GO in the presence of polyamines using the acid-base type electrostatic interaction. In presence of a mild reducing agent (vitamin C), one of these GO hydrogels has been transformed into a reduced graphene oxide (RGO)-based hydrogel by a simple in situ reduction of GO sheets within the hydrogel matrix. Moreover, noble metal nanoparticle containing RGO based hybrid hydrogels have been obtained using in situ and simultaneous co-reduction of GO and noble metal precursors within the GO gel matrix. The elegance of this method is in situ, "green chemical" and simultaneous reduction of GO and metal salts within the hydrogel matrix to form RGO-based hybrid gel and concomitant stabilization of metal nanoparticles (MNPs) within the gel system. The nascently formed MNPs are homogeneously and uniformly distributed on the surface of the RGO nanosheets within the hybrid gel. Interestingly, this MNP containing RGO-based hybrid hydrogel matrix acts as a potential catalyst for the reduction of aromatic nitro to amino group. The catalyst (hybrid gel matrix) can be separated easily after the reaction and reused several times.

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